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CONTENTS

PAGE

+ PRINGLE, J. A., M.Sc. Observations on certain
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OBSERVATIONS ON CERTAIN WOOD-BORING COLEOPTERA OCCURRING IN SOUTH AFRICA

By J. A. PRINGLE, M.Sc.

(University of the Witwatersrand, Johannesburg.)

(Read 1st June, 1938.)

WITH PLATE 1 AND FIVE TEXT-FIGURES.

CONTENTS.

	PAGE
Introduction	247
BOSTRYCHIDAE	248
<i>Xylopsocus sellatus</i> F.	249
<i>Heterobostrychus brunneus</i> Murray	253
<i>Xylion adustus</i> Fähr.	256
<i>Enneadesmus forficula</i> subsp. <i>capensis</i> Lesne	260
LYCTIDAE	263
Morphology of the larva of <i>Lyctus brunneus</i> Steph.	264
Summary	268
Acknowledgements	269
References	269
Key to the lettering of the figures	270
Explanation of the plate	270

INTRODUCTION.

Up to the present, knowledge of the biology of South African timber-boring beetles is very meagre and practically limited to observations on the economic aspect. This shortcoming may be due to the difficulty in obtaining material of all stages of development, and also to the difficulty of studying the successive stages which live concealed in the wood; it is certainly not due to a lack of economic importance of these insects.

The ravages of LYCTIDAE and BOSTRYCHIDAE in timber yards and in the wood of warehouses, etc., certainly merit a great deal more attention than they have hitherto received. The LYCTIDAE have been studied by Altson (1922 and 1923), who described the early larval stages of *Lyctus brunneus* Steph. and the method of oviposition and the egg of that species. In 1924 Snyder described the method of oviposition and egg of *Lyctus planicollis* LeConte, and Munro (1928) has given a brief account of the life cycle of *Lyctus brunneus* Steph. More recently Kojima (1932) published the first comprehensive work on *Lyctus linearis* Goeze. This excellent study deals with the biology, morphology, natural enemies and control measures, and is outstanding as the first complete piece of work dealing with all aspects of the problem in one particular Lyctid species.

The BOSTRYCHIDAE, which have been transported in timber and cereals all over the world, have received even less attention than the LYCTIDAE. Garnett (1922) gave an account of the biology of *Dinapate wrightii* Horn in palm trees (*Washingtonia filifera*) in lower California. Burgeon (1930) very briefly

described the habits of several Bostrychids and mentioned their natural enemies.

Within recent years economic entomologists have come to realise the value of biological observations on insects of economic importance, and, to-day, the necessity of a more thorough biological knowledge previous to undertaking control measures against insect pests is often emphasised.

The present paper deals with the biology of a few South African timber-boring Coleoptera, and as far as I am aware, no previous account of the early stages of these insects has been published, although descriptions of the adult stages, and in most cases of the habits, are available.

BOSTRYCHIDAE.

Introduction.

The BOSTRYCHIDAE constitute a family closely related to the LYCTIDAE. Not only has the morphology of the adult stage been neglected, but there is little information regarding their biology. This is the more surprising when it is realised that successful control depends largely on a thorough knowledge of the life history of the species concerned.

Most Bostrychids are specific in their attacks and prefer hard well-seasoned timber. This type of timber is usually of considerable economic value, but once ravaged by these beetles, its value is greatly depreciated, as the outer infested layer must first be removed before it can be used.

In South Africa, adults usually emerge during the spring, and infested wood, opened at this time of the year, will reveal adults, pupae and late larval instars. According to Burgeon (1930) the adults emerge from the pupal cell at night and copulation takes place. Migration is made in darkness, and after copulation the male assists the female in gnawing a channel into the wood. This is first cut straight into the wood to a depth equal to the length of the beetle, after which the excavation is parallel to the surface. As the wood is gnawed away, the waste is expelled from the burrow, which always remains open, presumably for the supply of air. The main tunnel may have several lateral passages and even a terminal chamber where the beetle can turn round. The eggs are laid at the end of the main tunnel, and the parents are usually found dead in the passage or at the original entrance. The dead bodies serve as a plug to close the tunnel and the eggs are thereby further protected.

The older larvae are found inhabiting cells which are parts of unfilled galleries. Unlike the adults, the larvae pack their galleries tightly behind themselves with excreta and waste wood particles. In tunnelling, the larva forces the tergal portion of the deflected abdomen firmly against the posterior end of the cell, and is thus able to exert considerably more pressure with the mandibles.

The prothorax, which is large and slightly hardened and fits neatly into the burrow, also gives rigidity to the head and mandibles while burrowing. The larva rotates in its burrow while gnawing, this constant rotation enabling it to cut a regular circular tunnel. The legs, which are short and flexible, are of little use as a support when tunnelling, but may assist in the rotation of the body, and in conveying the unused wood particles past the thorax.

The larvae are capable neither of free locomotion nor of re-entering the wood when once removed. They abstain from eating wood other than that which they themselves have gnawed in a gallery. When placed in a petri-

dish with sawdust and chips of wood from the timber in which they occur, death usually results after a lengthy period of starvation.

By some unknown sense they always excavate parallel to the surface, never coming so close as to expose themselves, and usually burrowing just a little deeper into the wood than the previous generation. In this way timber is ravaged from the outside, the larvae going systematically deeper with each successive generation.

Prior to pupation the larvae of the final instar begin tunnelling towards the surface, and as they reverse their position just before pupation, the pupa is usually found in a cell close to the surface, with its head facing the channel excavated by the larva.

Xylopsocus sellatus (F.).

This Bostrychid was brought to my notice through the kindness of Mr. Thoroughgood of the Timber Exchange Yard, Johannesburg, on 23 August, 1934. In the timber yard it was found to attack only Wattle (*Acacia melanoxylon* R. Br.) which had been barked and left lying in the yards for more than one year, being thus subjected to all kinds of weather conditions. On examination of the timbers at the Exchange Yard, it was found that the relative incidence of attack was very slight, only a few of the exposed poles being infested. The beetle had doubtless been introduced into the yard in the timber, and had probably not yet had time to increase and attack other stacks. Infested timber was easily noticed by the number of exit holes of the adults, which, in South Africa, emerge during the early months of spring.

In one instance it was found that the adult female had entered the wood by a small aperture and that she had then excavated three radiating burrows from 1 cm. to 2.5 cm. in length (fig. 6, d). Several eggs were laid at the end of one burrow, the small channels packed with pulverised wood indicating where the first instar larvae had commenced to burrow.

The larvae of the final instar, just prior to pupation, turn round in their cell and often burrow for a short distance in the opposite direction, so that the pupa is always found with its head pointing in the reverse direction to that in which the larva was first burrowing.

Owing to scarcity of material no further observations on the biology and early stages were made.

Morphology of the larva.

Only the last two stages of larvae occurred in the wood and their measurements were respectively 4 mm. and 5.5 mm. in length and 1.8 mm. and 2.0 mm. across the thorax. The following description is that of the final instar larva.

The larva (fig. 1, b) is of a milky-white appearance, with a strongly deflected abdomen. It is of the eruciform type, having a cylindrical body and three pairs of thoracic legs.

Head.

The head (fig. 1, c) is small, oval, retractile and sunk deeply into the thorax, only the mouth-parts and frons being exposed dorsally. The epicranial suture (e.s.) is distinct to the line where the prothoracic membrane meets the head capsule. The frons (f.) is hardened and setose with a concave anterior margin. The clypeus (cl.) is a transverse sclerite, articulating with the frons by the fronto-clypeal suture. It bears two tufts of setae on the posterior corners. Ocelli are absent.

Head appendages.

The antennae (fig. 1, e) are situated near the antero-lateral border of the head capsule. Each is a three-segmented structure, and being retractile, the basal segment (1) is membranous. The second segment (2) is sclerotised only in the lower half and bears a ring of setae equatorially placed. The terminal segment (3) is cone-shaped, twice as long as broad, and terminates in a pair of long sensory setae. This segment bears a small lateral process (proc.) which is not separated off distinctly enough to be termed a fourth segment of the antenna, though it, nevertheless, resembles the fourth antennal segment of larval LYCTIDAE.

Mouth-parts.

The labrum (lr., fig. 1, c) has a trilobate anterior margin which is overhung by numerous short setae. Each mandible (fig. 1, f) is heavily sclerotised, conical in shape and with a sharp anterior cutting edge. The condyle (cond.) is large and almost spherical. In each maxilla, the cardo (cd., fig. 1, d) is small and membranous, while the stipes (st.) is large and well sclerotised along its medial edge. There is a number of setae located at the base of the maxillary palp. The galea (gal.) is rounded and densely covered with setae, while the lacinia (lac.) is a median sclerotised spine, closely apposed to the galea. Altson (1924) and Kojima (1932) name these two structures the lacinia, but in several BOSTRYCHIDAE there is the median spine which would represent the lacinia of typical mouth-parts. Böving and Craighead (1931) also distinguish a galea and lacinia. The maxillary palp (mx. p.) is a three-segmented structure, having the two basal segments broader than long, with the anterior portion of each setose. The terminal segment is longer than broad and is furnished apically with several sensory papillae.

In the labium, the mentum (m., fig. 1, d) and the submentum (s.m.) are membranous and separated by a complete suture. The mentum has two tufts of medial setae while the submentum is regularly setose, anteriorly and laterally. The prementum is situated at the base of the palps. The labial palps (l.p.) are conical, two-segmented structures. Only the basal segment is setose, while the terminal segment has several apical sensory papillae. The hypopharynx (hyp.) is densely setose over the whole surface just above the labial palps, but farther back setae only occur on the two marginal sclerotised rods which meet after a short distance. Lying farther back in the mouth is an arch-shaped structure attached to the hypopharynx by the two arms. From the distal end of this structure arise laterally two sclerotised rods, which are upwardly directed into the mouth cavity and meet the downwardly projecting epipharyngeal rods from the labrum.

Thorax.

The thorax (th., fig. 1, b) is large, slightly hardened and narrowed anteriorly to meet the small head capsule. The prothorax has a pair of spiracles on the epimeral region. The mesothorax has a well-developed pleuron overhanging the sternum. The metathorax is membranous and lobate, while the pleuron is so reduced that the whole of the leg is seen in lateral view. The sternites are membranous and slightly convex.

The three pairs of legs are forwardly directed and each is situated on the sternum immediately below the tergum. They are all similar except that the first pair is more strongly developed than the others. The first segment

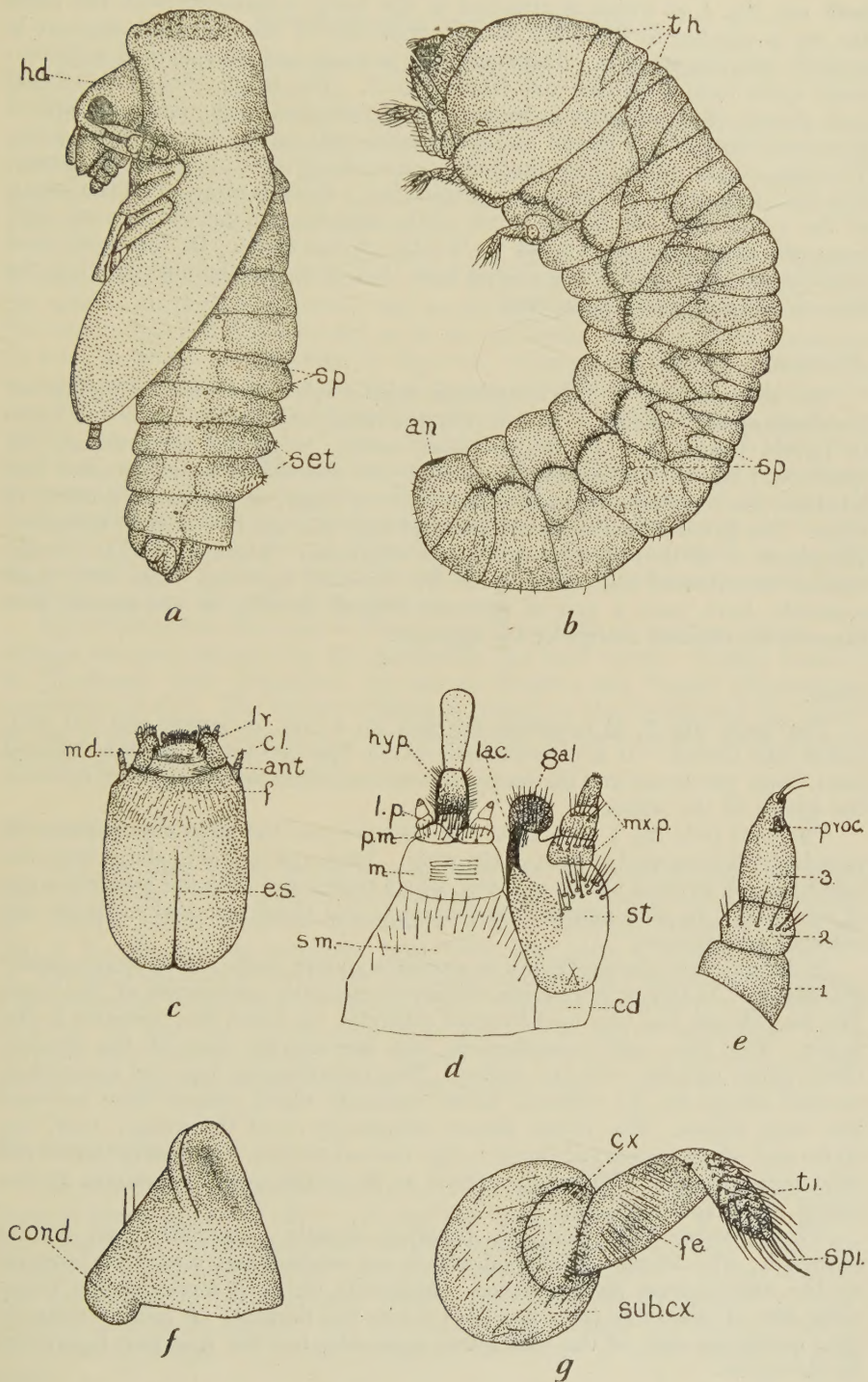


FIG. 1.—*Xylopsocus sellatus* (Fab.), a. pupa; b. larva; c. dorsal view of the head; d. maxilla and labium; e. right antenna, dorsal view; f. right mandible, ventral view; g. right prothoracic leg, lateral view.

(sub. ex., fig. 1, g) which is attached to the body is hemispherical, but since the leg is parallel to the body, the anterior side of this subcoxal segment is sunken into the sternite. The coxa (cx.) is small and subspherical with two short spurs located on the coxo-femoral joint. The femur (fe.) is cylindrical and almost twice as long as broad. It is furnished with numerous lateral setae and there is one lateral and one medial spur on the femoro-tibial joint. The tibia (ti.) is conical and directed downwards at right angles to the femur. The tibia terminates in a long curved spine (spi.) which is almost half the length of the tibia. The distal two-thirds of the segment are densely covered with long stiff setae reaching almost to the tip of the spine. In the meso- and metathoracic legs the spine is shorter than that of the prothoracic legs, but the setae are as long as the tibia itself.

Abdomen.

The abdomen (fig. 1, b) is cylindrical, greatly lobed and with the pleura not overhanging the sternites. Altson (1922) divided each segment into four lobes in Lyctid larvae, namely the scutellar, scutal, epipleural and sternal. In Bostrychid larvae, however, only the first two abdominal segments show this lobation, the remaining segments have either a lesser, or a greater, number of lobes. The five terminal segments are not lobed, and can be ventrally deflected. The pleura of all the segments are fringed with setae. The anus (an.) is a longitudinal slit situated mid-ventrally on the terminal segment. The first eight segments have each a pair of spiracles located dorsally to the pleural lobe towards the anterior margin of the segment.

Pupa.

The pupa (fig. 1, a) measures 4.5 mm. to 5 mm. in length and 1.5 mm. across the thorax. It is characteristic of the BOSTRYCHIDAE, with a deflexed head, large prothorax and the terminal tarsal segments projecting from between the apices of the wings.

The head (hd., fig. 1, a) is small, cone-shaped and the large mouth-parts lie parallel to the humeral margin of the wing. Each eye is oval in shape with the lower portion covered by the antenna, which terminates over the humeral angle of the wing. In each antenna the proximal and three terminal segments are enlarged and distinct.

In lateral view the prothorax is almost a square, with the anterior surface granulated. It slopes downwards steeply to meet the epicranium of the head. The mesothorax has two medial notal tubercles, of which the posterior is the larger. The pro- and mesothoracic legs are sharply bent at the femoro-tibial joints and lie over the elytra. The metathoracic legs are completely covered except for the terminal tarsal segments which project from between the wing apices. The elytra almost completely cover the wings; both the elytra and wings are curved round to the ventral surface of the body but do not meet mid-ventrally. The wings extend as far as the posterior margin of the fourth abdominal segment.

The abdomen is cylindrical, tapering slightly posteriorly and ending abruptly. The tergal and sternal plates are evident and separated laterally by the membranous pleural region. Segments three to seven have a transverse row of stiff setae (set., fig. 1, a) across the dorsum. A pair of spiracles (sp.) occurs on each of the first seven segments, but the first pair is covered by the elytra.

Heterobostrychus brunneus Murray.

Material of this species was obtained from Mr. Thoroughgood of the Timber Exchange Yard, Johannesburg.

The adults emerge during the summer months in South Africa and are most active at night, when copulation takes place. After copulation the female tunnels into the wood for about 1 cm. (pl. 1, figs. 2 and 3), it then reverses its position and begins working parallel to the surface. It constructs no side passages as does *Xylopsocus sellatus* (F.).

The pupae are usually found about 1 cm. from the surface in a cell 2 cm. in length and 2.5 mm. in diameter. The larva does not establish contact with the outside air prior to pupation, and as the pupa measures 9.5 mm. to 12 mm. the large pupal cell may thus act as an air chamber. The larval cell measures 15 mm. in length and 3.5 mm. in diameter, whereas the fully extended larva measures only 9 mm., thus when the abdomen is deflected there is a considerable gap behind the larva when tunnelling. In this case, as the larva is unable to utilise the posterior end of the cell for support, it forces the deflected abdomen against the sides of its burrow, and by this means the necessary pressure is brought to bear on the mandibles. The deflected abdomen is further used as a pseudopod for moving backwards and forwards in the tunnel. The larva performs the process of packing the gallery behind itself, by moving backwards to the posterior end of its cell and thus forcing the excreta and wood particles against the end of its burrow.

Heterobostrychus brunneus is found over the whole of southern Africa. It attacks seasoned timber only and preferably the hard woods. I have found it in Rhodesian teak (*Copaifera coleosperma* Benth.) and Kejaat (*Pterocarpus angolensis* D. C.). The extent of damage caused by this beetle and its larvae in any type of wood must be very considerable in view of the large tunnels that it excavates (pl. 1, fig. 3).

Morphology of the larva.

Only the final instar larvae were collected in the wood during November and December 1934. This larva measures 9 mm. in length and 4 mm. across the thorax. It is white in appearance with a strongly deflected abdomen (fig. 2, b). It is of the eruciform type, with three pairs of thoracic legs.

The head (fig. 2, c) is fairly large, rectangular and deeply sunk into the thorax. The epicranial suture (e.s.) is straight and unforked, extending relatively far forward, so that the frontal area is reduced to a narrow sclerotised band covered with delicate setae. The clypeus (cl.) is a broad transverse sclerite with a tuft of lateral setae at its fronto-clypeal margin. Ocelli are absent.

Head appendages.

The antennae are situated on the antero-lateral border of the head capsule. Each is three-segmented (fig. 1, d) and the basal segment (1) is membranous and retractile. The second segment (2) is broader than long and bears a ring of setae arranged near its distal margin. The third segment (3) is flask-shaped and terminates in three sensory setae. Several setae are located on this segment close to its anterior end, and in addition a single seta occurs towards the posterior margin. The third segment also bears a small medial process (proc.).

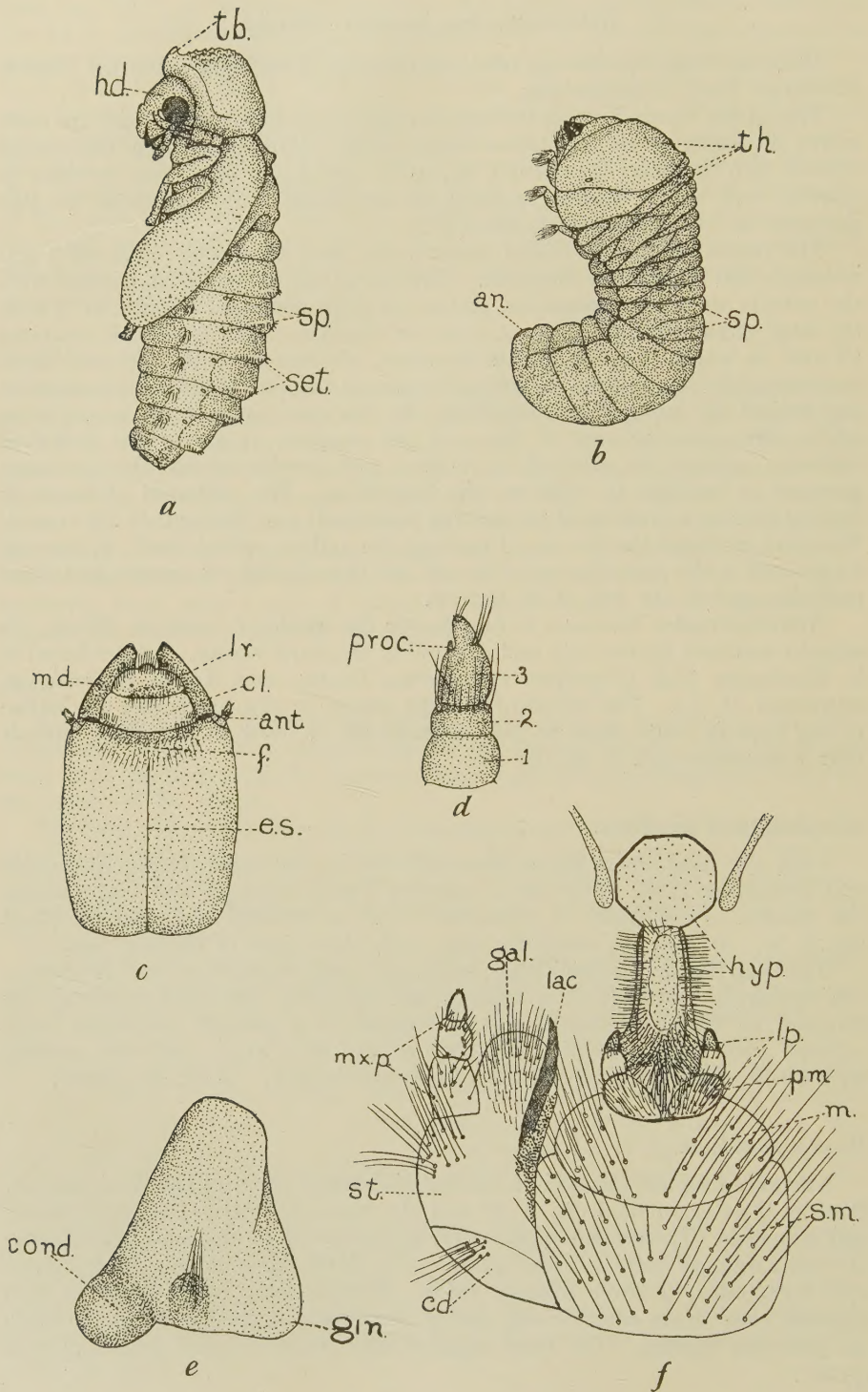


FIG. 2.—*Heterobostrychus brunneus* Murr., a. pupa; b. larva; c. head, dorsal view; d. right antenna, dorsal view; e. left mandible, lateral view; f. maxilla and labium.

Mouth-parts.

The labrum (lr., fig. 1, c) has a trilobate anterior margin, with the median lobe smaller than the lateral lobes, therein differing from *Xylopsocus sellatus* (F.). The mandible (fig. 1, e) has the posterior portion heavily sclerotised, with a sharp anterior medial cutting edge. Between the condyle (cond.) and the ginglymus (gin.) is a tuft of long setae.

In each maxilla (fig. 1, f), the cardo (cd.) bears a patch of setae near its anterior margin. The stipes (st.) is sclerotised anteriorly along the medial edge and this sclerotisation terminates in a stout outwardly directed spine. The galea (gal.) is densely covered with setae, while the lacinia (lac.) is an elongate medial spine. The galea and lacinia are more distinct in this species than in *Xylopsocus sellatus* (F.). The maxillary palp (mx. p.) is three-segmented, each segment being longer than broad. The first and second segments are furnished with seta and the third rather conical segment has a number of apical sensory papillae.

The labium (fig. 1, f) has the mentum (m.) and submentum (s.m.) distinctly separated and both covered with long setae. The prementum (p.m.) is densely setose. The palps (l.p.) are two-segmented conical structures. In each the first segment bears a few setae anteriorly while the terminal segment is heavily sclerotised. The hypopharynx (hyp.) is densely covered with setae; these are also continued between the labial palps, and distally they are disposed laterally on the two parallel marginal sclerites. The second part is unlike that of *Xylopsocus sellatus* (F.), being almost circular in shape, and from it arise laterally the two rods which project dorsally to meet the ventrally directed rods of the epipharynx.

Thorax.

The thorax (th., fig. 1, b) is hardened and slopes abruptly to meet the head. The prothorax has a pair of spiracles located on the epimera. The metathorax is membranous and lobate. The sternites are slightly convex.

The three pairs of legs are forwardly directed and slightly elevated from the body surface. The first or subcoxal segment is large and hemispherical. The coxa is small and bears two short spurs, one medial and one lateral, which project over the coxo-femoral joint. The femur is almost twice as long as broad with numerous setae along the lateral surface. There are two short spurs on the anterior margin of the femur, one lateral and one medial, projecting over the femoro-tibial joint, at which the leg is sharply flexed. The tibia is conical and terminates in a spine which is often hidden within the dense mass of tibial setae. These setae are long and cover the whole segment.

Abdomen.

The abdomen is subcylindrical and the anterior segments are folded dorsally. The five terminal segments are smoother but are ventrally deflected. The pleural lobes of all the abdominal segments are fringed with setae. The anus (an.) is a longitudinal slit on the ventral surface of the terminal segment. Each of the first eight abdominal segments bears a pair of spiracles (sp.), each of which is situated dorsally to the pleural lobe and towards the anterior margin of the segment.

Pupa.

The pupa (fig. 2, a), which measures 9.5 mm. to 12 mm. in length and 3 mm. across the thorax, is characteristic of the genus, having a deflexed head

and the terminal tarsal segments of the metathoracic legs projecting from between the wing apices.

The head (hd.) is small and conical. The eye is almost circular and the anterior margin is covered by the antenna. Each antenna has the basal and three terminal segments enlarged, and the latter terminate over the humeral angle of the wing.

In lateral view the prothorax is oblong with the anterior surface rugose. It differs from *Xylopsocus* in having a pair of backwardly directed tubercles (tb.) on the anterior margin of the prothorax, which slopes steeply to meet the head. The meso- and metathorax have each a single medial notal tubercle, but that on the latter segment is considerably smaller than that on the mesonotum. The pro- and mesothoracic legs overlie the wings and are sharply bent at their femoro-tibial joints. The metathoracic legs are completely covered except for the terminal tarsal segments which project from between the wing apices. The elytra which almost completely cover the wings are curved on to the ventral surface of the body and reach to the middle of the fourth abdominal segment.

The abdomen is cylindrical to the sixth segment, after which it tapers ventrally and terminates bluntly. The tergal and sternal plates are evident and are separated laterally by the membranous pleural region. Segments two to seven have each a transverse row of short stiff setae (set.) located over the crest of the tergum and situated towards the posterior margin of each segment. A tuft of setae is situated dorsally to the sternite of each segment. Each of the first seven segments bears a pair of spiracles (sp.) on the pleural region. The pair on the first segment is covered by the elytra.

Xylion adustus (Fähræus).

Specimens of *Xylion adustus* were sent to Dr. Paterson of Witwatersrand University from the Timber Exchange Yard, Johannesburg, on 6 March, 1933, and she handed over to me several preserved specimens of adults, pupae and larvae, together with some infested timber. The timber most readily attacked by this Bostrychid is seasoned Rhodesian teak (*Copaifera coleosperma* Benth.), but occasionally it is found also in *Eucalyptus globulus* Labill. As it seems to have a distinct preference for hard woods, it may be of some economic importance, but as far as could be ascertained from observations at the timber yard, the damage there was not extensive and considerable difficulty was experienced in obtaining material. In South Africa the adults emerge during the summer months. They are grotesquely adorned on the wing apices with several posteriorly directed spines, the use of which is, as yet, unknown.

Morphology of the larva.

The larvae of the last two instars measure 7 mm., and 5 mm. in length and 2 mm. and 1.8 mm. across the thorax respectively. The following is a description of the larva in the last instar. It is of the eruciform type (fig. 3, b) with a deflected abdomen and three pairs of thoracic legs.

Head.

The head (fig. 3, d) is oval and deeply retractile within the thorax. The mouth is directed ventrally so that in lateral view only part of the latero-dorsal surface of the head capsule is visible. The epicranial suture (e.s.) is about half the length of the head capsule. The frons (f.) is hardened and setose.

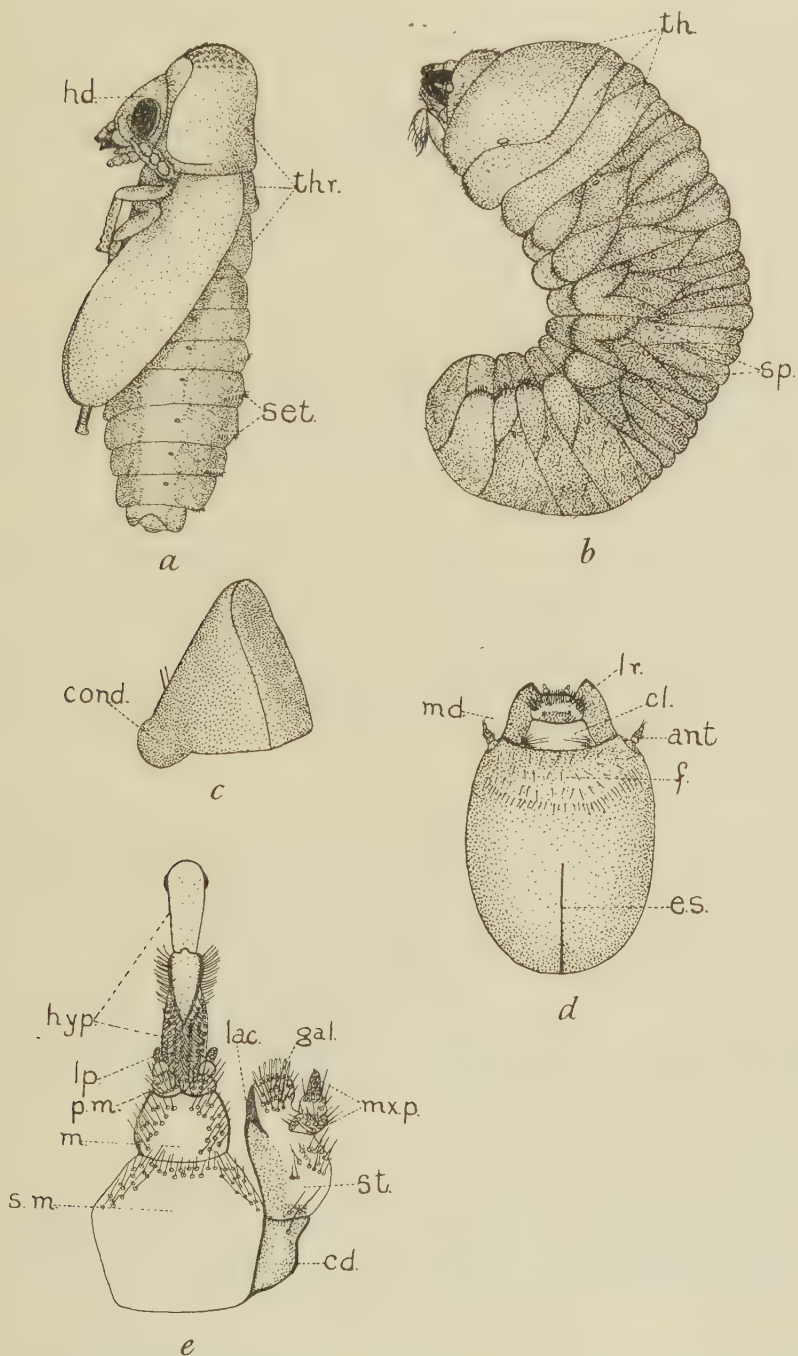


FIG. 3.—*Xylion adustus* (Fähr.), a. pupa; b. larva; c. right mandible, ventral view; d. head, dorsal view; e. maxilla and labium.

The clypeus (cl.) is a transverse sclerite with a patch of setae located in the postero-lateral corners, at the fronto-clypeal suture. Ocelli are absent.

Head appendages.

The three-segmented antennae (ant., fig. 3, d) are located near the antero-lateral margin of the head. In each, the first segment is membranous and allows the antenna to be partly retracted within the head capsule. The second segment bears a ring of setae anteriorly. The third segment is flask-shaped and terminates in a pair of sensory setae. It bears a small process situated medially in a niche, wherein it differs from *Xylopsocus* where it is lateral in position.

Mouth-parts.

The labrum (lr., fig. 3, d) has a trilobed anterior margin, overhung by numerous setae, and the posterior half of this sclerite is heavily sclerotised. The attachments of the epipharynx are indicated by a pair of lateral sclerotisations.

Each mandible (fig. 3, c) is conical in shape with an anterior medial cutting edge, and closely resembles that of *Xylopsocus sellatus* (F.). The condyle (cond.) which articulates with the gena is rounded.

In each maxilla (fig. 3, e), the cardo (cd.) is peripherally sclerotised and usually bears one distal seta, but there may be more. The stipes (st.) is sclerotised along its articulation with the labium, and this sclerotisation terminates anteriorly in a spine, the lacinia (lac.) lying adjacent to the galea (gal.). A tuft of setae occurs posteriorly to the base of the palp. The galea is densely setose, covered with stiff setae, but those fringing the anterior margin are larger and blade-shaped. In each three-segmented palp (mx. p.) the two basal segments are furnished with setae and the terminal segment with sensory papillae.

Labium.

The mentum (m.) and submentum (s.m.) are distinctly separated by a suture. The latter has the anterior and antero-lateral borders setiferous, while in the former setae only occur laterally. The prementum (p.m.) is situated at the base of the labial palps. The latter (l.p.) are two-segmented conical structures, the terminal segment is small and heavily sclerotised, while the sensory papillae usually found at the apex of this segment are absent. The hypopharynx (hyp.) is directed backwards into the mouth cavity from the base of the labial palps. It is covered with numerous medially directed setae, and distally the setae are arranged on two marginal sclerotised areas. Connected distally to the latter is an arch-shaped sclerite which closely resembles that of *Xylopsocus*.

Thorax.

The thorax (th., fig. 3, b) is slightly hardened and tapers anteriorly to meet the head capsule. The pleural lobes overhang the sternites to such an extent that the two posterior pairs of legs are completely obscured in lateral view. A pair of spiracles is situated on the epimeral region of the prothorax.

Legs.

The three pairs of legs are forwardly directed and very closely apposed to the body. They are all similar except that the first is more strongly developed. The large subcoxal segment is hemispherical and fused with the body wall.

The coxa is small and furnished with two short spurs, one medial and one lateral, which project over the coxo-femoral joint. The femur is almost twice as long as broad and covered with setae ventrally. It bears a pair of short spurs, one lateral and one medial, which project over the femoro-tibial joint. The tibia is conical and articulates with the femur at an angle. It is densely covered with long setae and terminates in a curved claw. The meso- and meta-thoracic pairs of legs have setae on the tibia which are as long as the segment itself.

Abdomen.

The abdomen (fig. 3, b) is cylindrical and lobate, and with the pleural region clearly defined but not obscuring the sternites. The three terminal segments are not lobed, and they are sparsely covered with setae over the tergal region. The pleura of all the segments are fringed with setae. The anus is a longitudinal slit located on the terminal segment. The first eight segments are each furnished with a pair of spiracles (sp.), each of which is situated dorsal to the pleural lobe towards the anterior margin of the segment.

Pupa.

The pupa (fig. 3, a) measures 5.5 mm. in length and 1.8 mm. across the thorax. It is of a milky-white colour and the abdominal segments are flexible. It is typical of the BOSTRYCHIDAE, having a deflexed head, three large terminal antennal segments and the terminal tarsal segments of the metathoracic pair of legs projecting from between the wing apices. The head (hd.) is short and conical while the mouth-parts project out at right angles to the long axis of the body. In each antenna the basal and three terminal segments are enlarged, and the distal segment lies over the femoro-tibial joint of the prothoracic leg. The eye is oblong, the anterior border covered by the antenna.

The thorax (thr.) is equal to the length of the first seven abdominal segments, while the prothorax is longer than the meso- and metathoracic segments together. The prothorax is cone-shaped in lateral view, with the anterior surface rugose. It slopes down abruptly to meet the small head capsule. As in the pupa of *Xylopsocus sellatus* (F.) the mesothorax has two notal protuberances, of which the anterior is the smaller. The pro- and mesothoracic legs are sharply bent at the femoro-tibial joint and slightly overlap the humeral margin of the wing. The pair of metathoracic legs is covered by the wings except for the terminal tarsal segments, which project between their apices. The wings are bent round the body and almost touch on the ventral surface. The elytra, which extend as far as the fourth abdominal segment, almost completely cover the wings.

The cylindrical abdomen is approximately of the same diameter throughout. There is, however, a slight diminution posteriorly before the blunt terminal segment. The tergal and sternal plates are separated by a membranous pleural region. Segments three to seven are each furnished with a row of dorsal setae (set.), situated transversely in the posterior half of each tergum. Each of the first seven segments bears a pair of spiracles, which is located on the pleural region. The first pair is covered by the elytra. Morphologically the larva and pupa of this species approach more closely to those of *Xylopsocus sellatus* (F.) than to those of *Heterobostrychus brunneus* Murr., probably indicating a closer relationship to the former species.

Enneadesmus forficula subsp. *capensis* Lesne.

Material of this species was obtained from Barkly West district, Cape Province, on 20 October, 1934, the infected wood being a dry branch of *Acacia karroo* Hayne. It has not yet been ascertained whether this species normally attacks *A. karroo* H. or whether this is merely an accidental infestation. If *A. karroo* H. is its only "host," then one would expect this Bostrychid to be widely distributed throughout the northern Cape, southern Bechuanaland, south-western Transvaal and western Orange Free State. As the timber of *A. karroo* H. is not used to any extent commercially, the ravages of this Bostrychid may not be of great economic importance.

Biology.

The adults emerge in South Africa during the summer months and copulation takes place at night. On examining the wood in October, larvae of the last instars, as well as pupae and adults, were found. One may conclude that these are all stages belonging to the same generation, which began its cycle in the previous year. The life cycle is thus an annual one, the insect hibernating in the larval stage.

The pupae, as usual, are found near the surface with the head pointing in the opposite direction to that in which the larva was originally tunnelling. On emerging from the pupal cell, the head and thorax of the adult are of an amber colour, while the abdomen is white. The adult soon establishes contact with the exterior by a small aperture, and a rapid change into its characteristic dark colour takes place.

Morphology of the larva.

The larva (fig. 4, b) is of a translucent white, the intestine showing as a light brown band through the dorsal abdominal wall.

The final instar larva measures 5 mm. in length and 2 mm. across the thorax, while the earlier stage measures 4.5 mm. and 1.7 mm. respectively. The larva is of the eruciform type, with a subcylindrical body, provided with three pairs of short thoracic legs.

Head.

The head (fig. 4, c) is small, oval and sunk into the thorax. The prothorax overlaps the head capsule to about one-third of the length from the anterior margin of the latter, so that the vertex and occiput are completely covered. The epicranial suture (e.s.) reaches the anterior margin of the frons (f.), which is hardened and is laterally setiferous. The clypeus (cl.) is an oblong, transverse sclerite with a tuft of setae on each side near the fronto-clypeal suture, which is almost straight. Ocelli are absent.

Head appendages.

The three-segmented antennae (ant., fig. 4, c) are situated on the antero-lateral border of the head. As each antenna is retractile, the basal segment is membranous and without setae. The second segment is as long as broad and encircled by a ring of six equatorial setae. The third segment is flask-shaped and terminates in two long sensory setae. The latter segment also bears a small process which is laterally situated.

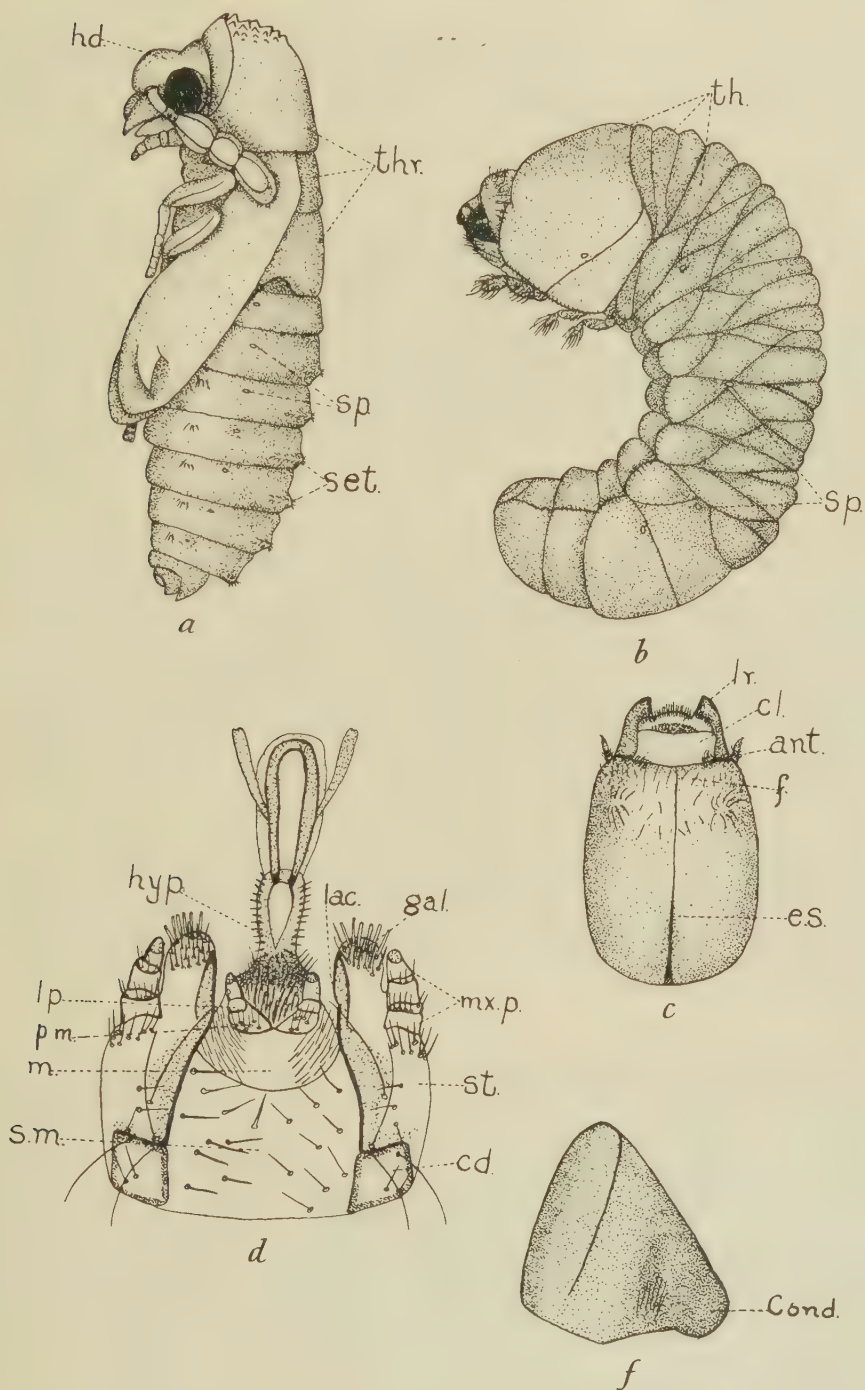


FIG. 4.—*Enneadesmus forficula* Fairm., a. pupa; b. larva; c. head, dorsal view; d. maxilla and labium; e. right mandible.

Mouth-parts.

The labrum (lr., fig. 4, c) is a narrow sclerite, the posterior half of which is heavily sclerotised. The anterior margin is trilobed and overhung by numerous setae. Each mandible (fig. 4, f) is a well-developed structure resembling that of *Heterobostrychus brunneus* Murr. The condyle (cond.) articulates in a sclerotised socket of the gena.

The maxillae (fig. 4, d) are lateral and closely adherent to the labium. In each, the cardo (cd.) is a square sclerite peripherally sclerotised. There are two setae on the cardo and two which are more elongate near the cardo-stipital suture. The stipes (st.) is sclerotised along the medial edge, which terminates in a spine, the lacinia (lac.), which is closely attached to the galea (gal.). There are several very elongate setae towards the posterior portion of the stipes and several more, which are shorter, situated at the base of the palp. The galea is densely covered with blade-shaped setae as in *Xylion adustus* (Fähr.). The two basal segments of the three-segmented maxillary palp (mx. p.) have each a setiferous ring round their anterior margins, and the third segment terminates in a number of sensory papillae.

Labium.

The mentum (m.) and submentum (s.m.) are separated, and while the latter is sparsely setose the former is densely covered with setae laterally. The prementum (p.m.) bears the two-segmented labial palps (l.p.) the terminal segment of which bears a sensory pore. The hypopharynx is densely covered with setae over the area distal to the palps; farther back in the mouth the setae are disposed along two marginal sclerotisations. Distal to the latter is an arch-shaped structure which bears two lateral sclerotisations projecting dorsally into the mouth cavity. These in turn meet the pair of epipharyngeal rods which project downwards from the labrum.

Thorax.

The prothorax (fig. 4, b) and part of the mesothorax are hardened and taper anteriorly to meet the head. The metathorax is lobed and the pleuron of each side does not overhang the sternum, as do the pleura of the pro- and mesothoracic segments. There is a single pair of spiracles situated on the epimera of the prothorax.

Legs.

The three pairs of legs are forwardly directed, but the first pair is not only better developed but also more closely apposed to the body than the other two pairs. The first or subcoxal segment is hemispherical and sparsely setose. The coxa is small and bears a pair of short stout spines on the coxo-femoral joint. The femur is almost twice as long as broad, with several rows of setae between the anterior and posterior margins. There are two spines, one medial and one lateral, on the femoro-tibial joint. The tibia is bent almost at right angles to the femur; it is cone-shaped and terminates in a long curved spine. The anterior two-thirds of this segment are covered with long stiff setae. In the meso- and metathoracic pairs of legs these setae are subequal in length.

Abdomen.

The abdomen (fig. 4, b) is subcylindrical and consists of ten, some greatly folded, membranous segments. The five terminal segments are capable of

ventral deflection and are not lobed dorsally. The pleura, which slightly overhang the sternites, are fringed with setæ. The anus, which is located on the terminal segment, is a longitudinal slit. The first eight segments have each a pair of spiracles situated dorsally to the pleural region towards the anterior margin of the segment.

Pupa.

The pupa (fig. 4, a) measures 3.5 mm. to 5 mm. in length and 1 mm. to 1.3 mm. across the thorax. It is milky-white in colour and characteristic of the family with the deflexed head, and the terminal tarsal segments of the hind legs projecting from between the apices of the wings.

On the head (hd.), the frons is arched and meets the labrum between the bases of the antennae. In these the basal and three last segments are enlarged, while the end segment of each antenna lies over the humeral angle of the wing. The seven antennal segments intermediate between the basal and three last segments are very slender. The eye is oval and slightly raised from the head posteriorly.

The prothorax is almost rectangular in shape when seen laterally. Its anterior surface is rugose and the lateral surface slopes steeply to meet the head. The meso- and metathorax are subequal in size, being smaller than the prothorax. The pro- and mesothoracic legs lie closely apposed to the body and are sharply bent at the femoro-tibial joints. The metathoracic legs are completely covered by the wings, except for the terminal tarsal segments, which project from between the wing apices. The wings are curved ventrally but they do not meet on the lower surface. The elytra almost cover the wings, and reach to the fourth abdominal segment. Unlike the other BOSTRYCHIDAE described above, each elytron has a large peculiar spine which is posteriorly directed and located near the apex.

The first five abdominal segments are cylindrical, while the rest of the abdomen tapers ventrally and ends abruptly. In each of segments two to seven there is a transverse dorsal ridge which is fringed with short stout setae (set.), and in addition segments one to seven also have a tuft of setae on the pleura. There are seven pairs of spiracles (sp.), situated on the pleural region, in each case the peritreme is concolorous with the body wall.

LYCTIDAE.

Introduction.

Information regarding the biology of the LYCTIDAE is somewhat scattered, there being only one complete account dealing with the life history of a Lyctid species.

Altson (1923) described the method of oviposition and the egg of *Lyctus brunneus* Steph. and Snyder (1916) that of *Lyctus planicollis* LeConte, and in this respect a difference may be noticed between them and the BOSTRYCHIDAE. In the latter, the eggs are laid in a burrow constructed by the adults, while in the former, according to Altson and Snyder, the eggs are deposited in cracks and crevices on the outside of the timber. By means of a long ovipositor, the female is able to probe into small apertures until she locates a suitable site for the eggs. Two or more eggs are laid longitudinally in juxtaposition in a vessel in the wood. The developing embryo lives on the residual yoke mass during the latter half of its embryonic life. Development takes fifteen days.

Altson (1922) described the larvae of the first and second instars of *Lyctus*

brunneus Steph., while Munro (1915) gave only a comparative account of the final instar larva of *Lyctus brunneus* Steph. and the larvae of the ANOBIIDAE. So far, the only contribution which deals comprehensively with the biology, morphology and natural enemies of a species of *Lyctus*, is that of Kojima (1932), who discusses all these aspects in *Lyctus linearis* Goeze. I have thought it advisable, therefore, on account of the disconnected nature of the information regarding the LYCTIDAE, to give a complete description of the larva and pupa of *Lyctus brunneus* Steph. as found in South Africa, referring where necessary to previous accounts of this and other species of LYCTIDAE. Various workers such as Munro (1928) and Altson (1922) have contributed towards the biology of this species and my observations on its life history in South African timbers agree fully with their accounts.

It is known that *Lyctus brunneus* Steph. is attacked in the adult stage by the adults of *Tarsostenus univittatus* (Rossi) and in the larval stage by the larvae of this Clerid beetle. I have found larvae, pupae and adults of this predacious beetle together with those of *Lyctus brunneus* Steph. St. George (1924) gave an account of the method of oviposition and the description of the first instar larva of *Tarsostenus univittatus*, while Böving and Champlain (1920) described the final instar larva, and I hope to publish shortly a description of the pupa. I have found also cocoons of a Hymenopteron, probably *Eubadizon pallidipes* (Nees) (BRACONIDAE), in the galleries.

Morphology of the larva of Lyctus brunneus Steph.

The last larval stage measures 4.5 mm. to 5.5 mm. in length, and 1.8 mm. across the thorax, and the width of the head is 1.3 mm. The larva (fig. 5, b) is of a milky-white appearance, with the abdomen ventrally deflected. It is of the eruciform type with three pairs of thoracic legs.

Head.

The head (fig. 5, f) is oval, retractile and deeply sunk into the thorax. The epicranial suture (e.s.) reaches to half the length of the head capsule. Munro (1915) clearly shows the arms of the epicranial suture diverging to meet the anterior margin of the frons. In the specimens which I examined these arms of the epicranial suture could not be distinguished. The frons (f.) is narrow and setose. The epistome, on which Munro (1915) bases his larval classification of the ANOBIIDAE and LYCTIDAE, is not a separate sclerite as he shows it, but part of the clypeus, and in this respect the larva of *Lyctus brunneus* Steph. seems to agree with that of *Lyctus linearis* Goeze, which, according to Kojima (1932), has also no epistome. Laterally there is a tuft of elongate setae near the fronto-clypeal suture.

Altson (1922) refers to "a pair of rudimentary eyes composed of pigment spots, situated below and posterior to the antennae." All the larvae which I examined are blind, and Kojima (1932) has also recorded a similar fact for *Lyctus linearis* Goeze.

Head appendages.

The antennae (ant., fig. 5, f) are retractile and situated near the antero-lateral border of the head. The basal segment (1, fig. 5, e) is membranous and broader than long. The second segment (2) is furnished with six long setae. The third segment (3) is much longer than broad and bears five long setae—three medial and two dorsal. The segment terminates in a single sensory

papilla and in addition has a dorsal sensory pore. The fourth segment (4) is small and situated on the lateral border of the third segment.

Mouth-parts.

The labrum (lr., fig. 5, f) is a transverse sclerite, with a trilobed anterior margin which is overhung by numerous setae. The posterior half of this sclerite is sclerotised, and in this portion are two sclerotisations which indicate the points of attachment of the epipharyngeal rods.

Each mandible (fig. 5, d) is large and heavily sclerotised with a sharp anterior cutting edge. Each has a medial club-shaped projection (clb.), called the pseudomola by Böving and Craighead (1931), which bears a brush of setae posteriorly. The medial surface of the pseudomola is serrate. Situated on the medial border of the mandible is a large transparent structure (trs., fig. 5, d), the lacinia mandibulae of Böving and Craighead (1931), which according to Kojima (1932) is not comparable with a prostheca. According to Altson (1922) the pseudomolae come into operation when the mandibles are opened and in the act of biting. Their function is thus to crush the wood whilst the setae of the brushes strain or align it before passing into the pharynx. Kojima (1932) considers that the laciniae mandibulae act as a trough on which the wood particles are collected and conveyed to the pseudomolar surface.

Each maxilla (fig. 5, g) has a triangular cardo (cd.) devoid of setae. The stipes (st.) is sclerotised along the medial edge and this terminates in a long outwardly curved spine (lac.) probably comparable with a reduced lacinia. The galea (gal.) bears several long setae as well as four or five stout spines. Proximal to the base of the lacinia are three stout bristles as long as the maxillary palp. The galea and lacinia are together termed the lacinia by Altson (1924) and Kojima (1932), but, as two processes resembling those of Bostrychid larvae are present, it seems more correct to designate them the galea and lacinia. The posterior border of the stipes bears several setae, and a single seta is also located on the external lateral border. The stipital setae, however, are not constant in their arrangement and even vary in the two stipites of one specimen. The palp (mx. p.) is three-segmented; the first and second segments each bear numerous setae, the third lacks setae terminating in several sensory papillae.

In the labium (fig. 5, g), the mentum (m.) and the submentum (s.m.) are membranous with scattered setae. A prementum (p.m.) is present and is setose anteriorly and laterally. The labial palps (l.p.) consist of only a single segment and each is provided with three sensory pores.

The first part of the hypopharynx (hy. 1) consists of an elevated area sparsely covered with setae and situated between the bases of the palps. Distal to the latter in the mouth cavity is an oblong area having a wide margin covered with setae and leaving only a small clear area, in the centre of which the salivary glands (s.g.) open. Attached to the distal margin of the latter is a broad, angular, membranous structure (hy. 2), which projects dorsally into the mouth cavity. From the distal border of the latter arises a pair of sclerotised rods (rd.), which first extend posteriorly, then turn dorsally to meet a large, horseshoe-shaped sclerotised structure (h.s.), which is located on the ventral surface of the clypeus. This structure is covered with numerous delicate setae, but between the arms is a sclerotised area, devoid of setae, which is slightly excavated. The opening (op.) into the pharynx is a transverse slit extending between the bases of the arms of the horseshoe-shaped structure. Attached to the dorsal surface of the latter are two sclerotised rods (ch.), which extend to the ventral

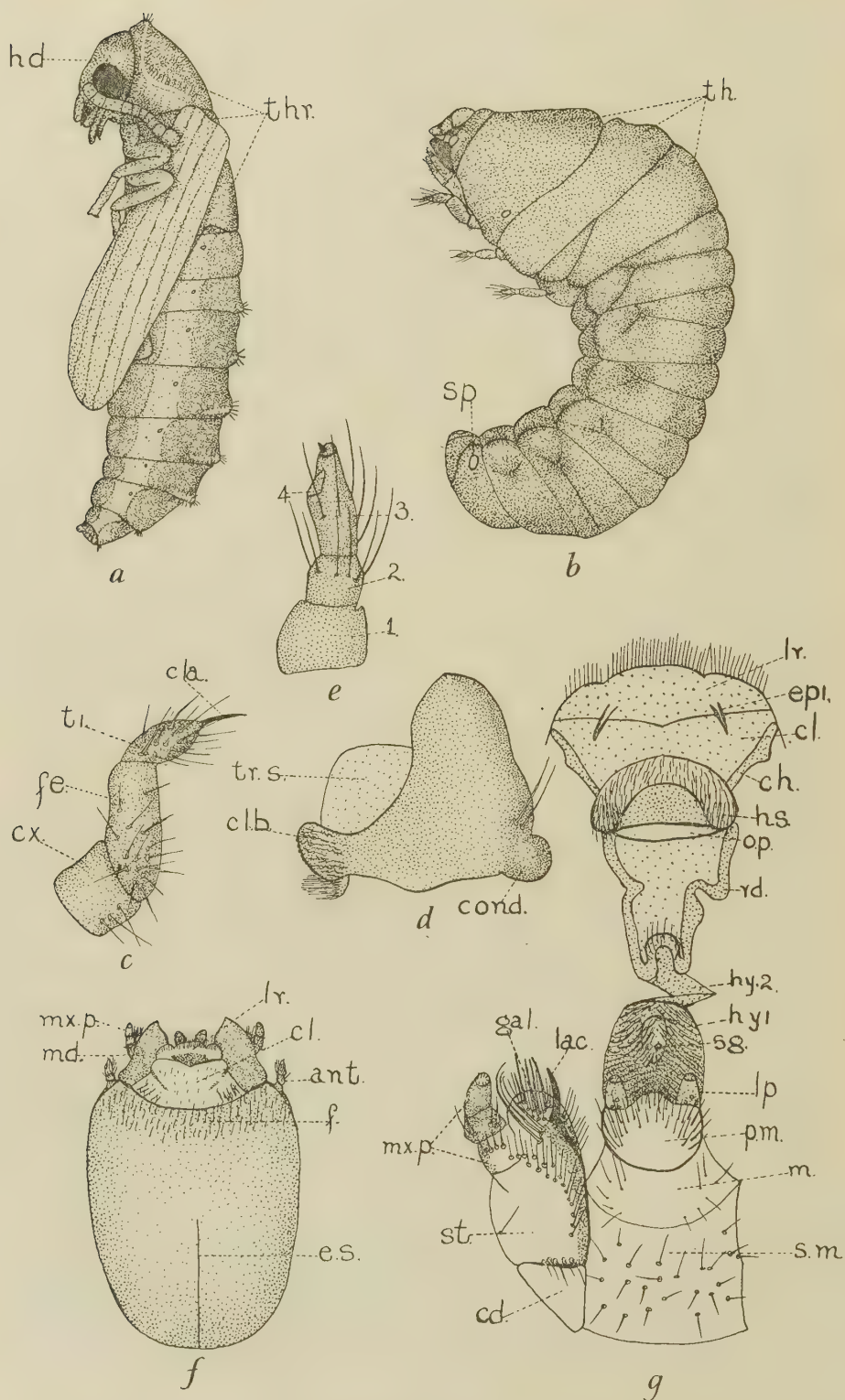


FIG. 5.—*Lyctus brunneus* Steph., a. pupa; b. larva; c. right prothoracic leg, lateral view; d. right mandible, dorsal view; e. left antenna, dorsal view; f. head, dorsal view; g. maxilla, labium and hypopharynx.

surface of the clypeus, to which they fuse and are visible through this membranous sclerite in fig. 5, g. The epipharyngeal rods (epi.) are short and not in contact with any of the afore-mentioned structures. This description compares closely with that of Kojima (1922) for *Lyctus linearis* Goeze.

Thorax.

The thorax (fig. 5, b) is hardened and tapers anteriorly to meet the head. The prothorax bears a pair of spiracles on the epimera. The sternites are membranous and slightly convex.

Legs.

The three pairs of thoracic legs are forwardly directed and elevated at an angle to the body. The first pair is more strongly developed than the remaining two. Each leg (fig. 5, c) is three-segmented. The first or coxal segment (cx.) is short, cylindrical and articulates with the sternite. The femur (fe.) is more than twice the length of the coxa and covered with numerous setae. In the first pair of legs the tibia projects almost at right angles from the femur, but in the other two pairs the leg is much straighter and terminates in a long curved claw.

Abdomen.

The abdomen is subcylindrical, unsclerotised and capable of great ventral flexion. The pleurae of all the segments are fringed with setae. The anus is a longitudinal slit on the terminal segment. Munro (1915) has named the lobes of the abdomen the prescutal, scutellar, epipleural and hypopleural, while Altson (1922) has renamed these the scutal, the scutellar, epipleural and sternal lobes respectively. These lobes are not utilised for classificatory purposes nor to any appreciable extent in descriptions of the larvae and, at present, under the existing differences of terminology are rather confusing.

Each of the first eight abdominal segments bears a pair of spiracles, which is located dorsal to the pleural lobe. The last pair of spiracles (sp., fig. 5, b) is almost six times as large as any of the others.

Pupa.

The male pupa measures 4.0 mm. in length and 1.0 mm. across the thorax, and in the female 5.0 mm. and 1.0 mm. respectively. The pupa (fig. 5, a) is of a milky-white appearance and only the terminal abdominal segments are capable of movement.

The head (hd.) is deflected ventrally, but the trophi do not touch the ventral surface of the body. Each eye is large, oval and located posteriorly to the base of the antenna. Each antenna is ten-segmented and terminates in two enlarged segments, which lie over the humeral angle of the elytra. The prothorax, when viewed laterally, is triangular in shape and there is an anterior, transverse ridge fringed with setae, which continues posteriorly along the lateral margin. The meso- and metathoracic segments are sub-equal and almost obscured by the elytra. The pro- and mesothoracic legs lie over the elytra, but the metathoracic legs are concealed beneath the wings, except for the femoro-tibial joints which project on to the third abdominal segment below the elytra. The elytra, which are curved to the ventral side of the body, almost completely conceal the wings, and have several longitudinal parallel ridges on the dorsal surface.

The abdomen is cylindrical to the fifth segment, after which it tapers ventrally. The tergite and sternite of each segment are visible as hardened plates, between which lies the membranous pleuron. On segments two to six, towards the posterior margin there is a transverse tergal ridge which is fringed with short stout setae. The first seven abdominal segments each bear a pair of spiracles on the pleural region.

SUMMARY.

Differences between the BOSTRYCHIDAE and LYCTIDAE.

	BOSTRYCHIDAE	LYCTIDAE
<i>Pupa.</i>		
(1) Thorax.	Prothorax enlarged, usually square in lateral view, anterior surface rugose. Mesothorax has one or two notal tubercles.	Prothorax smaller, usually triangular in lateral view, anterior edge fringed with setae. Notal tubercles absent from mesothorax.
(2) Legs.	Terminal tarsal joints of the metathoracic legs project from between the wing apices.	Terminal tarsal joints of the metathoracic legs do not project from between the wing apices.
<i>Larva.</i>		
(a) Head.		
(1) Mandible.	No pseudomola. No lacinia mandibulae.	Pseudomola present. Lacinia mandibulae present.
(2) Labium.	Palps two-segmented.	Palps one-segmented.
(3) Antennae.	Three-segmented plus process.	Four-segmented.
(b) Thorax.		
(1) Legs.	Large subcoxal segment.	Subcoxal segment absent.
(c) Abdomen.	Spiracles all of equal size.	Terminal pair of spiracles six times as large as the others.
Habits.	Adult male and female tunnel into the wood and female lays her eggs in the channels.	Adult females lay their eggs in crevices in the wood.

Owing to their similar habitats the BOSTRYCHIDAE and LYCTIDAE have certain characteristics in common :

- (1) The adults * all possess an elongate body, which facilitates movement through the channels in the wood.
- (2) The larvae constitute the most destructive phase in the life cycle.
- (3) It is probably the larval stage that is introduced into new areas and countries, while the adults may be responsible for a local spread of the species.
- (4) The larvae utilise the wood as food, and the excreta fill the tunnels behind the larvae.
- (5) The larvae require little oxygen, as they are often confined to the limits of a small cell far below the surface of the wood.
- (6) The general body colour of the larvae is translucent white in correlation with their concealed mode of life.

* Except a few BOSTRYCHIDAE.

The larvae of both families are of the eruciform type and the pupae are exarate.

Detailed accounts of the morphology of the larvae and pupae of both families are given.

ACKNOWLEDGEMENTS.

I wish to express my deep appreciation to Professor van der Horst and Dr. Paterson for their guidance and assistance in the preparation of the present work. I am indebted to the following helpers for material which they have collected and forwarded to me at the University: Miss R. Lurie, University of the Witwatersrand, members of the staff of the Timber Exchange Yard, Johannesburg, and to several friends who have also assisted. I wish to thank Dr. Hesse of the South African Museum, Capetown, for naming specimens of LYCTIDAE and BOSTRYCHIDAE. I am indebted to Mr. V. L. Bosazza, University of the Witwatersrand, for the four photographs of infested timber.

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KEY TO THE LETTERING OF THE FIGURES.

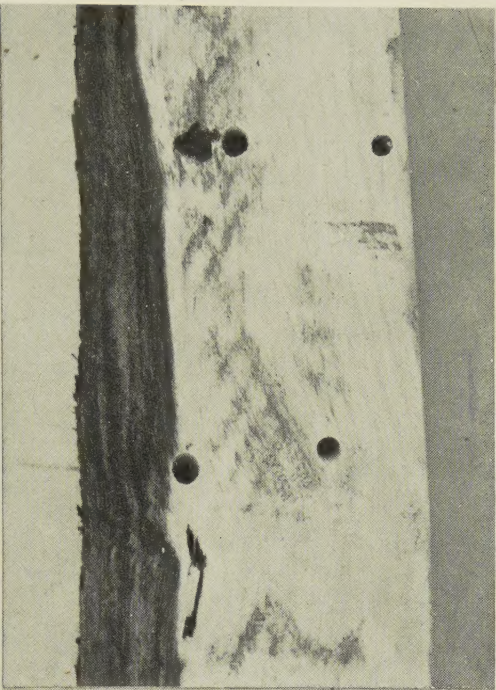
an.	anus.	md.	mandible.
ant.	antenna.	mx. p.	maxillary palp.
cd.	cardo.	o.p.	opening leading from the mouth into the pharynx.
ch.	sclerotised rods.	p.m.	prementum.
cl.	clypeus.	proc.	process of the third antennal seg- ment.
cla.	terminal claw of the leg.	rd.	sclerotised rod.
clb.	pseudomola of the mandible.	set.	setae.
cond.	condyle.	s.g.	openings of the salivary glands.
cx.	coxa.	s.m.	submentum.
epi.	epipharyngeal rod.	sp.	spiracle.
e.s.	epicranial suture.	spi.	tibial spine.
f.	frons.	st.	stipes.
fe.	femur.	sub. cx.	subcoxa.
gal.	galea.	tb.	prothoracic tubercle.
hd.	head.	ti.	tibia.
h.s.	horseshoe-shaped structure.	th.	thorax of the larva.
hy. 1.	first part of hypopharynx.	thr.	thorax of the pupa.
hy. 2.	second part of hypopharynx.	trs.	lacinia mandibulae.
hyp.	hypopharynx.	1, 2, 3, 4.	first, second, third and fourth antennal segments.
lac.	lacinia.		
l.p.	labial palp.		
lr.	labrum.		
m.	mentum.		

EXPLANATION OF PLATE 1.

FIG. 1. Wood of *Acacia* sp. opened to show the channels excavated by *Enneadesmus forficula*; 2. timber of *Pterocarpus angolensis* showing the large surface entrances made by the adults of *Heterobostrychus brunneus*; 3. timber of *Pterocarpus angolensis* opened to show the excavations of the larvae and adults of *Heterobostrychus brunneus*; 4. timber of *Acacia melanoxylon* opened to show (a) the channels caused by the larvae, (b) the cavity in the centre from which the adult female of *Xylopsocus sellatus* constructed three radiating burrows; evidently the eggs were laid at the terminus of the main burrow, as the channels of the first instar larvae commence from this excavation.



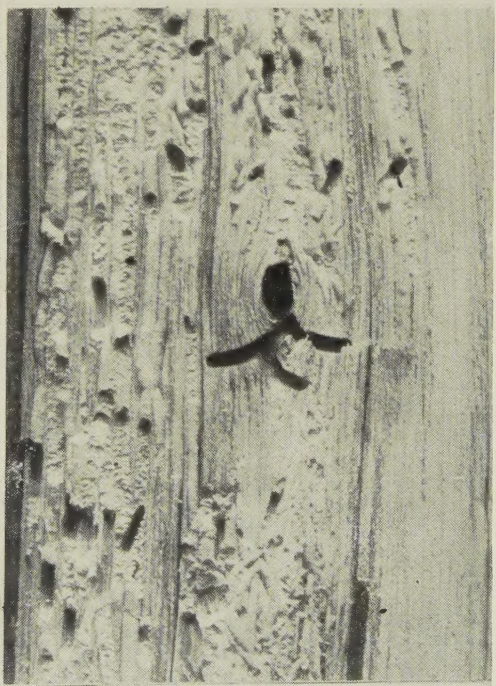
1



2



3



4

ENGRAVED BY STAR ILLUSTRATION, LONDON.

Timber damaged by wood-boring Coleoptera.

